

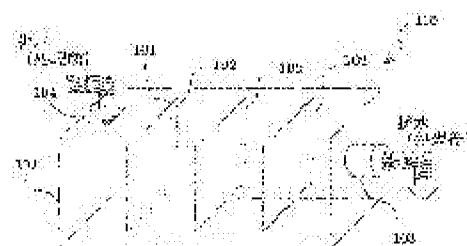
(11)Publication number : 2006-239474  
(43)Date of publication of application : 14.09.2006

*B01J 19/12 (2006.01)*  
*B01D 17/025 (2006.01)*  
*B01J 27/22 (2006.01)*  
*B01J 35/02 (2006.01)*

(72)Inventor : FURUYA MASAHIRO  
TOKIWAI MORIYASU  
TAKAHASHI TAKESHI  
KOBAYASHI HIROKAZU  
TANAKA NOBUYUKI  
MIKAMI MIKI  
KURODA MASAHIRO

**PROBLEM TO BE SOLVED:** To provide oil treatment equipment used in oil treatment facilities for treating waste water containing oil discharged from a business cookroom or the like and having sanitation maintenance and durability capable of withstanding practical use.

**SOLUTION:** In the oil treatment equipment, a multi-functional material in which a multi-functional surface comprising carbon-doped titanium oxide or oxidized titanium alloy is provided on at least part of the surface is used as a structure.



**\* NOTICES \***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

---

**CLAIMS**

---

[Claim(s)]

[Claim 1]

Oil disposal equipment, wherein multifunctional material in which the surface provided a multifunctional layer which consists of titanium oxide or a titanium alloy oxide by which the carbon dope was carried out in part at least is used as a structure.

[Claim 2]

Oil disposal equipment which said multifunctional layer is formed in one on the surface of a base, and this carbon is doped in the state of Ti-C combination in claim 1, and is characterized by a surface layer being titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least of this base.

[Claim 3]

Oil disposal equipment which said base consists of the surface part formative layer and heartwood which consist of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide in claim 2, and is characterized by these heartwood being construction material other than titanium, a titanium alloy, titanium oxide, and a titanium alloy oxide.

[Claim 4]

Oil disposal equipment characterized by Vickers hardness of said multifunctional layer being 300 or more in claim 2 or 3.

[Claim 5]

Oil disposal equipment characterized by Vickers hardness of said multifunctional layer being 1000 or more in claim 2 or 3.

[Claim 6]

The surface side at least Titanium, a titanium alloy, Oil disposal equipment, wherein multifunctional material which provided a multifunctional layer by which it has many heights of the surface of a base which consists of a titanium alloy oxide or titanium oxide which consist of titanium oxide or a titanium alloy oxide in part at least, and the carbon dope of this height is carried out is used as a structure.

[Claim 7]

Oil disposal equipment, wherein a detailed pillar stands close together in said multifunctional

layer and the carbon dope of this detailed pillar is carried out [ and ] in claim 6.

[Claim 8]

Oil disposal equipment characterizing by containing doped carbon in the state of Ti-C combination in claim 6 or 7.

[Claim 9]

Oil disposal equipment which it sets they to be [ any of claims 6-8 ], and said base consists of the surface part formative layer and heartwood which consist of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, and is characterized by these heartwood being construction material other than titanium, a titanium alloy, titanium oxide, and a titanium alloy oxide.

[Claim 10]

Oil disposal equipment, wherein which oil disposal equipment of claims 1-9 is a grease trap.

[Claim 11]

Oil disposal equipment with which said multifunctional layer is characterized by forming a wall and a diaphragm in part at least in claim 10.

[Claim 12]

Oil disposal equipment setting they to be [ any of claims 1-11 ], and providing a light source which irradiates said multifunctional layer with visible light or ultraviolet radiation.

---

[Translation done.]

## \* NOTICES \*

JPO and INPIT are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

---

## DETAILED DESCRIPTION

---

[Detailed Description of the Invention]

[Field of the Invention]

[0001]

This invention relates to the oil disposal equipment which processes the water containing an oil, such as a grease trap (oil separator) currently allocated in the business-use kitchen etc., for example.

[Background of the Invention]

[0002]

When oil pours as sewage the wastewater included mostly as it is, there are a problem of becoming a burden of sewage works, and a problem of polluting a river. Then, the grease trap which separates an oil and water as oil disposal equipment is used in the business-use kitchen, for example. This grease trap is a device which separates an oil and the aqueous phase and discharges only the aqueous phase as sewage by collecting the wastewater containing an oil etc.

About oil, it collects separately.

In order to collect the water containing an oil to the fixed time tub, the problem that an oil sticks to a nasty smell, aggravation, a wall of a sanitary aspect by putrefaction of an oil, etc. arises.

[0003]

Then, the measures of making an oil disassemble using a microorganism etc. are taken (the patent documents 1 and two references). However, there was the necessity of especially maintaining sanitary conditions highly in a kitchen, and these methods were insufficient.

[0004]

Here, although not conventionally used for a grease trap, there is what is called a photocatalyst to have decomposition and an antibacterial function. It seems however, to be unable to bear practical use, since the conventional photocatalyst material does not have sufficient photocatalyst function and does not have endurance.

[0005]

If a photocatalyst is detailed further, titanium dioxide  $\text{TiO}_2$  (in this specification and a claim, it is only called titanium oxide) is conventionally known as a substance which presents a

photocatalyst function. As a method of forming titanium oxide membrane on a titanium metal, from the 1970s. The method of forming titanium oxide membrane by anodization on a titanium metal, the method of forming titanium oxide membrane thermally on a titanium metal board in the electric furnace which supplied oxygen, The method of heating a titanium plate in the 1100-1400 °C flame of town gas, and forming titanium oxide membrane on a titanium metal, etc. are known (refer to nonpatent literature 1). Many researches for attaining utilization of a photocatalyst are done by many technical fields.

[0006]

When manufacturing the photocatalyst product from which the effect of deodorization, antibacterial properties, antifog, or antifouling is acquired by such a photocatalyst function, generally, spray coating, spin coating, dipping, etc. give titanium oxide sol on a base, and membranes are formed -- \*\*\*\* (for example, refer to patent documents 3-5) -- since it was easy to produce exfoliation and wear, the use over a long period of time was difficult for the coat formed such. How to form a photocatalyst coat by sputtering process is also known (for example, refer to patent documents 6-7).

[0007]

In order to operate titanium oxide as a photocatalyst, wavelength is required for ultraviolet rays of 400 nm or less, but many researches of the titanium oxide photocatalyst which dopes various elements and functions by visible light are done. For example, the titanium oxide which doped F, N, C, S, P, nickel, etc., respectively is compared, and there is a report that nitrogen doped titanium oxide is excellent as a visible light response type photocatalyst (refer to nonpatent literature 2).

[0008]

As a titanium oxide photocatalyst which doped other elements in this way, The titanium compound which replaces the oxygen site of titanium oxide by atoms, such as nitrogen, The photocatalyst which consists of a titanium compound which dopes atoms, such as nitrogen, between the lattices of the crystal of titanium oxide, or a titanium compound which arranges atoms, such as nitrogen, on the grain boundary of the polycrystal aggregate of a titanium oxide crystal is proposed (for example, refer to the patent documents 8 - 11 grade). However, such a photocatalyst is necessarily unsatisfying about the point of endurance, such as abrasion resistance.  $n\text{-TiO}_2\text{-xCx}$  which is chemical modification titanium oxide by applying the natural gas burning flame with which the temperature of the burning flame was maintained near 850 °C by adjusting the flow of natural gas and oxygen, for example to a titanium metal is obtained, There is a report of that this absorbs light of 535 nm or less (refer to nonpatent literature 3).

[0009]

. [ whether the crystal nucleus produced by various processes, such as a CVD method or PVD, is put in the sol solution which comprises an inorganic metal compound or an organic metallic compound, and ] Or by applying a sol solution to this crystal nucleus, solidifying it, heat-treating, and growing up a titanium oxide crystal from this crystal nucleus, the crystal form of the titanium oxide crystal grown up from the crystal nucleus accomplishes a columnar crystal -- high -- patent application of an activity photocatalyst function being obtained is carried out (for

example, refer to patent documents 12-14). However, since a columnar crystal only grows from the seed crystal only placed on the base in that case, the formed columnar crystal does not have the enough bond strength to a base, then the photocatalyst produced by making it such cannot necessarily be satisfied about the point of endurance, such as abrasion resistance.

[0010]

[Patent documents 1] JP,2004-057847,A

[Patent documents 2] JP,2000-350901,A

[Patent documents 3] JP,09-241038,A

[Patent documents 4] JP,09-262481,A

[Patent documents 5] JP,10-053437,A

[Patent documents 6] JP,11-012720,A

[Patent documents 7] JP,2001-205105,A

[Patent documents 8] JP,2001-205103,A (claim)

[Patent documents 9] JP,2001-205094,A (claim)

[Patent documents 10] JP,2002-95976,A (claim)

[Patent documents 11] The international publication 01st/No. 10553 pamphlet (CLAIMS)

[Patent documents 12] JP,2002-253975,A

[Patent documents 13] JP,2002-370027,A

[Patent documents 14] JP,2002-370034,A

[Nonpatent literature 1] A. Fujishima et al., J. Electrochem. Soc. Vol. 122, No. 11, p.1487-1489, November 1975

[Nonpatent literature 2] R. Asahi et al. and SCIENCE Vol. July 13, 2001 [ 293 or ], p.269-271

[Nonpatent literature 3] Shahed U. M. Khan et al. and SCIENCE Vol. September 27, 2002 [ 297 or ], p.2243-2245

[Description of the Invention]

[Problem(s) to be Solved by the Invention]

[0011]

An object of this invention is to provide the oil disposal equipment which has the health maintenance and endurance which use it in view of the situation mentioned above with the oil disposal equipment which processes the wastewater containing the oil discharged from a business-use kitchen etc., and can be equal to practical use.

[Means for Solving the Problem]

[0012]

The 1st mode of this invention that attains said purpose is in oil disposal equipment, wherein multifunctional material in which the surface provided a multifunctional layer which consists of titanium oxide or a titanium alloy oxide by which the carbon dope was carried out in part at least is used as a structure.

[0013]

In the 1st mode, said multifunctional layer is formed in one on the surface of a base, and the 2nd mode of this invention is doped in the state of Ti-C combination of this carbon, It is in oil

disposal equipment, wherein a surface layer is [ of this base ] titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least.

[0014]

In the 2nd mode, the 3rd mode of this invention said base, It consists of the surface part formative layer and heartwood which consist of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, and is in oil disposal equipment, wherein these heartwood is construction material other than titanium, a titanium alloy, titanium oxide, and a titanium alloy oxide.

[0015]

The 4th mode of this invention is in oil disposal equipment, wherein Vickers hardness of said multifunctional layer is 300 or more in a mode of the 2nd or 3.

[0016]

The 5th mode of this invention is in oil disposal equipment, wherein Vickers hardness of said multifunctional layer is 1000 or more in a mode of the 2nd or 3.

[0017]

The surface side at least the 6th mode of this invention Titanium, a titanium alloy, Have many heights of the surface of a base which consists of a titanium alloy oxide or titanium oxide which consist of titanium oxide or a titanium alloy oxide in part at least, and. This height is in oil disposal equipment, wherein multifunctional material which provided a multifunctional layer by which the carbon dope is carried out is used as a structure.

[0018]

The 7th mode of this invention has said multifunctional layer in oil disposal equipment, wherein a detailed pillar stands close together and the carbon dope of this detailed pillar is carried out [ and ] in the 6th mode.

[0019]

The 8th mode of this invention has the doped carbon in oil disposal equipment containing in the state of Ti-C combination in a mode of the 6th or 7.

[0020]

In which 6-8th modes, the 9th mode of this invention said base, It consists of the surface part formative layer and heartwood which consist of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, and is in oil disposal equipment, wherein these heartwood is construction material other than titanium, a titanium alloy, titanium oxide, and a titanium alloy oxide.

[0021]

The 10th mode of this invention is in oil disposal equipment, wherein oil disposal equipment of which 1-9th modes is a grease trap.

[0022]

The 11th mode of this invention has said multifunctional layer in oil disposal equipment, wherein a wall and a diaphragm are formed in part at least in the 10th mode.

[0023]

The 12th mode of this invention is in oil disposal equipment possessing a light source which irradiates said multifunctional layer with visible light or ultraviolet radiation in which 1-11th modes.

[Best Mode of Carrying Out the Invention]

[0024]

First, the multifunctional material which can be used for this invention is explained.

[0025]

The 1st multifunctional material used by this invention the surface of the base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, It is what is obtained by heat-treating hydrocarbon at an elevated temperature using the burning flame of the gas used as the main ingredients, It has a multifunctional layer which consists of a carbon dope titanium oxide layer which carbon is doped in the state of Ti-C combination, and is excellent in endurance (high hardness, scratch-proof nature, abrasion resistance, chemical resistance, heat resistance), and functions as a visible light response type photocatalyst as a surface layer.

[0026]

That is, the 1st multifunctional material used by this invention has a multifunctional layer which a surface layer consists of a carbon dope titanium oxide layer at least, and this carbon is doped in the state of Ti-C combination, and is excellent in endurance, and functions as a visible light response type photocatalyst.

[0027]

The 1st multifunctional material used by this invention can be manufactured when a surface layer heat-treats at least the surface of the base which consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide for hydrocarbon at an elevated temperature using the burning flame of the gas used as the main ingredients, for example. That is, it becomes the 1st multifunctional material that becomes the structural member by which the carbon dope titanium oxide layer was formed by this in the surface of titanium which is a surface layer of a base, a titanium alloy, a titanium alloy oxide, or titanium oxide in one, and the surface excels [ 1st ] in endurance, and functions as a visible light response type photocatalyst. This base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least, Even if the whole base comprises any of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide they are, it comprises the surface part formative layer and the heartwood which consist of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide, and those construction material may differ. Namely, titanium, the titanium alloy which are the surface layers of the base of a composite material in this case, It is good also as 1st multifunctional material that becomes the structural member by which the carbon dope titanium oxide layer was formed in the surface of a titanium alloy oxide or titanium oxide in one, and the surface excels [ 1st ] this in endurance, and functions as a visible light response type photocatalyst.

[0028]

When the base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least comprises the surface part formative layer and heartwood and those construction material differs, The thickness of the surface part formative layer may be the same as that of the carbon dope titanium oxide layer thickness formed, or (that is, the whole surface part formative layer turns into a carbon dope titanium oxide layer) may be thick



(that is, a part of thickness direction of the surface part formative layer serves as a carbon dope titanium oxide layer, and a part remains as it is). If the construction material of the heartwood burns, is fused or does not change in the case of the heat-treatment in the manufacturing method of the 1st invention, it will not be restricted in particular. For example, iron, an iron alloy, a nonferrous alloy, ceramics, other pottery, high-temperature-heat-resistance glass, etc. can be used as heartwood. As a base which comprises such a filmy surface layer and heartwood, For example, the thing which formed the coat which consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide on the surface of heartwood by methods, such as sputtering, vacuum evaporation, and thermal spraying, Or what gave commercial titanium oxide sol on the surface of heartwood by spray coating, spin coating, or dipping, and formed the coat can be mentioned.

[0029]

Publicly known various titanium alloys can be used as the above-mentioned titanium alloy, and it is not restricted in particular. For example, Ti-6aluminum-4V and Ti-6aluminum-6V-2Sn and Ti-6aluminum-2Sn-4Zr-6Mo, Ti-10V-2Fe-3aluminum and Ti-7aluminum-4Mo, Ti-5aluminum-2.5Sn, Ti-6aluminum-5Zr-0.5Mo-0.2Si, Ti-5.5aluminum-3.5Sn-3Zr-0.3Mo-1Nb-0.3Si, Ti-8aluminum-1Mo-1V and Ti-6aluminum-2Sn-4Zr-2Mo, Ti-5aluminum-2Sn-2Zr-4Mo-4Cr, Ti-11.5Mo-6Zr-4.5Sn, and Ti-15V-3Cr-3aluminum-3Sn, Ti-15Mo-5Zr-3aluminum, Ti-15Mo-5Zr, Ti-13V-11Cr-3aluminum, etc. can be used.

[0030]

In manufacture of the 1st multifunctional material, it is desirable to be able to use the burning flame of the gas which uses hydrocarbon, especially acetylene as the main ingredients, and to use especially a reducing flame. When hydrocarbon content uses little fuel, hardness becomes carbonaceous doped quantity is insufficient, or there is nothing, and insufficient as the result, and it becomes insufficient [ the photocatalyst activity under visible light ]. The gas which uses this hydrocarbon as the main ingredients in manufacture of the 1st multifunctional material used by this invention means the gas which does 50 capacity % content of hydrocarbon at least, for example, does 50 capacity % content of acetylene at least, and means suitably the gas which mixed air, hydrogen, oxygen, etc. In manufacture of the 1st multifunctional material used by this invention, it is preferred that the gas which uses hydrocarbon as the main ingredients contains acetylene in more than 50 capacity %, and it is most preferred that hydrocarbon is acetylene 100%. When unsaturated hydrocarbon, especially the acetylene which has a triple bond are used, it is a process of that combustion, and especially in a reducing flame portion, an unsaturation connecting part decomposes, an interim radical substance is formed, and it is thought that it tends to produce a carbon dope since this radical substance has strong activity.

[0031]

In manufacture of the 1st multifunctional material of this invention, when the surface layer of the base to heat-treat is titanium or a titanium alloy, the oxygen which oxidizes this titanium or a titanium alloy is required, and only the part needs to contain air or oxygen.

[0032]

Although the surface of the base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide is heat-treated at an elevated temperature in manufacture of the 1st multifunctional material used by this invention using the burning flame of the gas which uses hydrocarbon as the main ingredients, In this case, even if the burning flame of the gas which uses hydrocarbon as the main ingredients on the surface of a base is applied directly and it heat-treats at an elevated temperature, the surface of such a base may be heat-treated at an elevated temperature in the combustion gas atmosphere of the gas which uses hydrocarbon as the main ingredients, and this heat-treatment can be carried out for example, within a furnace. What is necessary is to burn the above fuel gas within a furnace and just to apply the burning flame to the surface of this base, in applying a burning flame directly and heat-treating at an elevated temperature. In heat-treating at an elevated temperature in combustion gas atmosphere, the above fuel gas is burned within a furnace and it uses the hot combustion gas atmosphere. When the base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least is powdered, . [ whether it introduces into a flame, predetermined time stagnation is carried out into a flame, and such powder is heat-treated, and ] Or. [ whether it is considered as the carbon dope titanium oxide doped in the state of carbon's Ti-C combination of the whole particle by changing the predetermined time maintenance of such powder into a fluid bed state into the combustion gas of the elevated temperature of a flow state, and ] It can be made the powder which has the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon.

[0033]

About heat-treatment, 900-1500 \*\* of skin temperature of a base needs to be 1000-1200 \*\* preferably, and it is necessary to heat-treat so that the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon as a surface layer of a base may be formed. It becomes insufficient [ the endurance of the base which has a carbon dope titanium oxide layer obtained ] in the heat-treatment which the skin temperature of a base finishes with less than 900 \*\*, and becomes insufficient [ the photocatalyst activity under visible light ]. On the other hand, in the heat-treatment whose skin temperature of a base exceeds 1500 \*\*, exfoliation of an ultra-thin film arises from the base surface part at the time of cooling after heat-treatment, and the effect of the endurance (high hardness, scratch-proof nature, abrasion resistance, chemical resistance, heat resistance) made into the purpose by the 1st invention is not acquired. Even if it is a case where it is the heat-treatment which becomes within the limits whose skin temperature of a base is 900-1500 \*\*, Since exfoliation of an ultra-thin film will arise from the base surface part at the time of cooling after heat-treatment and the effect of the endurance (high hardness, scratch-proof nature, abrasion resistance, chemical resistance, heat resistance) which is an important function of the 1st multifunctional material will not be acquired if heat-treatment time becomes long, It is required to be the time of the grade which does not bring exfoliation to the base surface part at the time of cooling after heat-treatment. That is, although the heat-treatment time is sufficient time for carbon to make this surface layer the carbon dope titanium oxide layer doped in the state of Ti-C combination, it needs to be

time not to bring about exfoliation of the ultra-thin film from the base surface part at the time of cooling after heating. Although this heat-treatment time is in cooking temperature and correlation, it is preferred that it is about 400 or less seconds.

[0034]

adjusting cooking temperature and heat-treatment time in manufacture of the 1st multifunctional material used by this invention -- carbon -- 0.3 - 15at% -- desirable -- 1 - 10at% -- the carbon dope titanium oxide layer doped in the state of Ti-C combination of the carbon to contain can be obtained comparatively easily. when there is little carbonaceous doped quantity, the carbon dope titanium oxide layer is transparent, and its carbonaceous doped quantity increases -- it being alike and following -- a carbon dope titanium oxide layer -- translucence -- it becomes opaque. therefore, the thing for which a transparent carbon dope titanium oxide layer is formed on transparent tabular heartwood -- endurance (high hardness.) The transparent plate which is excellent in scratch-proof nature, abrasion resistance, chemical resistance, and heat resistance, and functions as a visible light response type photocatalyst can be obtained, The decorative sheet which is excellent in endurance (high hardness, scratch-proof nature, abrasion resistance, chemical resistance, heat resistance), and functions as a visible light response type photocatalyst can be obtained by forming a transparent carbon dope titanium oxide layer on the board which has a colored pattern on the surface. The base in which a surface layer consists of titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide at least comprises the surface part formative layer and heartwood, and when the thickness of the surface part formative layer is 500 nm or less, If it heats to near the melting point of the surface part formative layer, boom hoisting of the shape of Kojima of a large number floating on the sea will arise on the surface, and will become translucent.

[0035]

In the 1st multifunctional material that has the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon, as for carbon dope titanium oxide layer thickness, it is preferred that it is not less than 10 nm, and in order to attain high hardness, scratch-proof nature, and abrasion resistance, it is much more preferred that it is not less than 50 nm. When carbon dope titanium oxide layer thickness is less than 10 nm, there is a tendency which becomes insufficient [ the endurance of the multifunctional material which has a carbon dope titanium oxide layer obtained ]. About the maximum of carbon dope titanium oxide layer thickness, although it is necessary to take cost and the effect attained into consideration, it is not restricted in particular.

[0036]

The carbon dope titanium oxide layer of the 1st multifunctional material used by this invention, Unlike conventional chemical modification titanium oxide and titanium oxide containing titanium compound Ti-O-X which dopes the various atoms or the anions X which are proposed from the former, carbon is contained comparatively so much and the doped carbon is contained in the state of Ti-C combination. As this result, mechanical strengths, such as scratch-proof nature and abrasion resistance, improve, and it is thought that Vickers hardness increases remarkably. Heat resistance also improves.

[0037]

The carbon dope titanium oxide layer of the 1st multifunctional material used by this invention has Vickers hardness of 1000 or more most preferably 700 or more still more preferably 500 or more 300 or more. The Vickers hardness of 1000 or more is harder than the hardness of hard chromium plating. Therefore, the 1st multifunctional material of this invention can be intentionally used for various technical fields for which hard chromium plating was used conventionally.

[0038]

As well as ultraviolet rays, the carbon dope titanium oxide layer which is a multifunctional layer of the 1st multifunctional material used by this invention also answers visible light with a wavelength of not less than 400 nm, and acts effectively as a photocatalyst. Therefore, the 1st multifunctional material used by this invention can be used as a visible light response type photocatalyst, and, also indoors, reveals a photocatalyst function as well as outdoor. The carbon dope titanium oxide layer of the 1st multifunctional material used by this invention shows the super-hydrophilic nature of 3 degrees or less of angles of contact.

[0039]

The carbon dope titanium oxide layer of the 1st multifunctional material used by this invention is excellent also in chemical resistance, A capable change was not seen, when coat hardness, abrasion resistance, and photoelectric current density were measured and it compared with the measured value before processing, after being immersed in each solution of 1M sulfuric acid and 1M sodium hydroxide for one week. Incidentally, about a commercial titanium oxide coat, since a binder generally dissolves in acid or alkali according to the kind, a film exfoliates, and acid resistance and alkali resistance are not almost.

[0040]

The carbon dope titanium oxide layer of the 1st multifunctional material used by this invention can be used also as a catalyst which also answers radiation, such as a gamma ray. Namely, although this invention persons have invented previously that spraying films, such as titanium oxide, answer radiation and control stress corrosion cracking, scaling, etc. of a nuclear reactor structural member, it, When the carbon dope titanium oxide layer of the 1st multifunctional material used by this invention is similarly used as such a radiation response type catalyst, The potential of a substrate is reduced, and pitting, general corrosion, and stress corrosion cracking can be controlled, and the effect that oxidizing power can decompose a scale, dirt, etc. is done so. As compared with the method of forming other radiation catalysts, it is simple, and excels also from a viewpoint of endurance, such as chemical resistance and abrasion resistance.

[0041]

A surface layer at least the 2nd multifunctional material Titanium, titanium oxide, On the surface of the base which consists of a titanium alloy or a titanium alloy oxide, unsaturated hydrocarbon, By applying especially the burning flame of acetylene directly, and heat-treating under specific conditions, or heat-treating the surface of this base in the combustion-gas atmosphere of unsaturated hydrocarbon, especially acetylene under specific conditions, The

layer which bristles with the detailed pillar which becomes an inside of this surface layer from titanium oxide or a titanium alloy oxide is formed, The member which the layer which makes the layer which bristles with this detailed pillar cut towards meeting this surface layer, and bristles with the detailed pillar on this base which consists of this titanium oxide or a titanium alloy oxide in part at least has exposed, The member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film, and this height has exposed is obtained, Namely, the thing for which these both have many surface heights which consist of titanium oxide or a titanium alloy oxide in part at least, Photocatalyst activity is high by carrying out the carbon dope of the detailed pillar which is a height which these both become from that it is useful multifunctional material and this titanium oxide, or a titanium alloy oxide, and the continuous narrow height, It functions as a visible light response type photocatalyst, and also can stick also to VOC easily, and hardness is also high and it excels in peeling resistance, abrasion resistance, chemical resistance, and heat resistance.

[0042]

Namely, the 2nd multifunctional material used by this invention has many surface heights which consist of titanium oxide or a titanium alloy oxide in part at least, The detailed pillar which stands close together on the narrow height which a large number which the layer which bristles with the surface detailed pillar which consists of titanium oxide or a titanium alloy oxide in part at least is exposed, or consist of titanium oxide or a titanium alloy oxide on a thin film followed, and this height is exposed, and For example, this height, For example, the carbon dope of this detailed pillar and this narrow height is carried out.

[0043]

The 2nd multifunctional material used by this invention heat-treats the surface of the base in which a surface layer consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide at least with the burning flame of unsaturated hydrocarbon, especially acetylene, Make the layer which bristles with the detailed pillar which consists of titanium oxide or a titanium alloy oxide form, and it ranks second to the inside of this surface layer, For example, give heat stress, shearing stress, and tensile force, make the layer which bristles with this detailed pillar cut towards meeting this surface layer, and at least on this base in part, The member which the layer which bristles with the detailed pillar which becomes most on this base from this titanium oxide or a titanium alloy oxide ordinarily has exposed, It can manufacture by obtaining the member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film, and this height has exposed, That is, it is the multifunctional material in which these both have many surface heights which consist of titanium oxide or a titanium alloy oxide in part at least, and is the 2nd multifunctional material that these both use by this invention.

[0044]

This base in which a surface layer consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide at least, It may comprise heartwood which consists of construction material of the surface part formative layer which the whole base may comprise any of titanium,

titanium oxide, a titanium alloy, or a titanium alloy oxide they are, or consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide, and others.

[0045]

The base in which a surface layer consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide at least, When it comprises heartwood which consists of construction material of the surface part formative layer which consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide, and others, Even if the thickness (quantity) of the surface part formative layer is thickness which is equal to the quantity of the layer which bristles with the detailed pillar which consists of titanium oxide or the titanium alloy oxide formed. (That is, it becomes the layer which bristles with the detailed pillar in which the whole surface part formative layer consists of titanium oxide or a titanium alloy oxide), It may be thicker than it (that is, it remains as it is without becoming the layer which bristles with the detailed pillar in which a part of thickness direction of the surface part formative layer consists of titanium oxide or a titanium alloy oxide and the remainder's changing). If the construction material of the heartwood burns, is fused or does not change in the case of the heat-treatment in manufacture of the 2nd multifunctional material used by this invention, it will not be restricted in particular. For example, iron, an iron alloy, a nonferrous alloy, glass, ceramics, etc. can be used as heartwood. As a base which comprises such a filmy surface layer and heartwood, for example, the thing which formed the coat which consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide on the surface of heartwood by methods, such as sputtering, vacuum evaporation, and thermal spraying, -- or, What gave commercial titanium oxide sol on the surface of heartwood by spray coating, spin coating, or dipping, and formed the coat can be mentioned. 0.5 micrometers or more are not less than 4 micrometers more preferably preferably about the thickness of this surface layer.

[0046]

Publicly known various titanium alloys can be used as the above-mentioned titanium alloy, it is not restricted in particular and the same thing as the 1st multifunctional material can be used.

[0047]

In manufacture of the 2nd multifunctional material used by this invention, it is desirable to use especially a reducing flame for example, using the burning flame of the gas which uses unsaturated hydrocarbon, especially acetylene as the main ingredients. 50 capacity % content of the gas which does 50 capacity % content of unsaturated hydrocarbon at least in manufacture of the multifunctional material of this invention, for example, acetylene, is done at least, and it is preferred to use the gas which mixed air, hydrogen, oxygen, etc. suitably. In manufacture of the 2nd multifunctional material used by this invention, it is most preferred that a fuel component is acetylene 100%. When unsaturated hydrocarbon, especially the acetylene which has a triple bond are used, It is a process of that combustion, especially in a reducing flame portion, an unsaturation connecting part decomposes, an interim radical substance is formed, since activity is strong, it is easy to produce a carbon dope and this radical substance is contained in the state of Ti-C combination of the doped carbon. Thus, if a carbon dope arises on a detailed pillar, the hardness of a detailed pillar will become high, mechanical

strengths, such as hardness of multifunctional material and abrasion resistance, improve as a result, and heat resistance also improves.

[0048]

Although a burning flame is directly applied to the surface of the base in which a surface layer consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide, and is heat-treated on it in manufacture of the 2nd multifunctional material used by this invention or the surface of this base is heat-treated in combustion-gas atmosphere, this heat-treatment -- for example, a gas burner -- or it can carry out within a furnace. What is necessary is just to apply the burning flame to the surface of this base with a gas burner, in applying a burning flame directly and heat-treating at an elevated temperature. What is necessary is to burn the above fuel gas within a furnace and just to use the atmosphere containing the hot combustion gas, in heat-treating at an elevated temperature in combustion-gas atmosphere.

[0049]

About heat-treatment, at least, a surface layer makes the layer which bristles with the detailed pillar which consists of titanium oxide or a titanium alloy oxide form, and ranks second to the inside of this surface layer that consists of titanium, titanium oxide, a titanium alloy, or a titanium alloy oxide, For example, the member which the layer which gives heat stress, shearing stress, and tensile force, makes the layer which bristles with this detailed pillar cut towards meeting this surface layer, and bristles with the detailed pillar on this base which consists of this titanium oxide or a titanium alloy oxide in part at least has exposed, It is necessary to adjust cooking temperature and heat-treatment time so that it may be possible to obtain the member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film, and this height has exposed. As for this heat-treatment, it is preferred to carry out at the temperature of not less than 600 \*\*.

[0050]

By heat-treating under such conditions, the intermediate whose average thickness of a detailed pillar the height of the layer which bristles with the detailed pillar is about 1-20 micrometers, the thickness of the thin film on it is about 0.1-10 micrometers, and is about 0.2-3 micrometers is formed. By giving heat stress, shearing stress, and tensile force, for example, and making the layer which bristles with this detailed pillar cut towards meeting this surface layer after that, The member which the layer which bristles with the detailed pillar on this base which consists of this titanium oxide or a titanium alloy oxide in part at least has exposed (that is, although most most [ all or ] which existed on the layer which bristles with the detailed pillar on a base exfoliate) remaining without some thin films which existed on the layer which bristles with the detailed pillar exfoliating -- it is -- the member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film, and this height has exposed can be obtained.

[0051]

In making the layer which heat stress is given to and bristles with the detailed pillar cut towards meeting a surface layer, it establishes a temperature gradient between the surface of a base,

and a rear face by cooling either one of the surface of a base, and a rear face, or, for example, heating. Whether it contacting any of the surface of the above-mentioned hot intermediate or a rear face they being as this cooling method on the object for cooling, for example, a stainless steel block, and cold (air of ordinary temperature) are sprayed on any of the surface of the above-mentioned hot intermediate, or a rear face they are. Even if it cools the above-mentioned hot intermediate radiationally, heat stress arises, but it is [ the extent ] low.

[0052]

In making the layer which shearing stress is given to and bristles with the detailed pillar cut towards meeting a surface layer, it gives the power of an opposite direction relatively to the above-mentioned surface and rear face of an intermediate according to frictional force, for example. In making the layer which tensile force is given to and bristles with the detailed pillar cut towards meeting a surface layer, it pulls the above-mentioned surface and rear face of an intermediate to an opposite direction in the perpendicular direction of those fields using a vacuum absorption board etc., for example. In using only the member which the layer which bristles with the detailed pillar on a base which consists of this titanium oxide or a titanium alloy oxide in part at least has exposed, The portion equivalent to the member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film of the above-mentioned intermediate, and this height has exposed is also removable by polish, sputtering, etc.

[0053]

In the member which the layer which bristles with the detailed pillar on the base produced by performing it above which consists of titanium oxide or a titanium alloy oxide in part at least has exposed, Although the height of the layer which bristles with the detailed pillar with the height position of the detailed pillar from which the layer which bristles with the detailed pillar was made to cut towards meeting a surface layer changes, the height of the layer which bristles with the detailed pillar is generally about 1-20 micrometers, and the average thickness of a detailed pillar is about 0.5-3 micrometers. This member can adsorb VOC easily, since surface area is large, the activity as a photocatalyst is high [ the member ], and also its coat hardness is also high, and it is the 2nd multifunctional material excellent also in peeling resistance, abrasion resistance, chemical resistance, and heat resistance.

[0054]

The member which the detailed pillar which stands close together on the narrow height by which a large number which consist of titanium oxide or a titanium alloy oxide continued on the thin film produced by on the other hand performing it above, and this height has exposed serves as small piece form, Although the height of the height on each wafer is about 2-12 micrometers and the height of this detailed pillar changes with the height positions of the detailed pillar from which the layer which bristles with the detailed pillar was made to cut towards meeting a surface layer, The height of the layer which bristles with the detailed pillar is generally about 1-5 micrometers, and the average thickness of a detailed pillar is about 0.2-0.5 micrometer. However, the narrow height which a large number followed without having made the layer which bristles with the detailed pillar cut towards meeting a surface layer and a



detailed pillar's almost existing depending on conditions may be exposed. This member can also adsorb VOC, and since surface area is large, the activity as a photocatalyst is high. Using as it is can also be pulverized, it can also be used, that grinding thing can also adsorb VOC easily, and since surface area is large, this member has the high activity as a photocatalyst.

[0055]

Since the carbon dope of the detailed pillar which stands close together on the narrow height which the detailed pillar which consists of titanium oxide or a titanium alloy oxide, and a large number followed in the 2nd multifunctional material used by this invention, and this height is carried out, As well as ultraviolet rays, visible light with a wavelength of not less than 400 nm is also answered, as a photocatalyst, especially, it can act effectively, and can be used as a visible light response type photocatalyst, and, also indoors, a photocatalyst function is revealed as well as outdoor.

[0056]

About the shape of each detailed pillar of the layer which bristles with the detailed pillar which consists of titanium oxide or the titanium alloy oxide which constitutes the 2nd multifunctional material used by this invention. So that it may be judged from the microphotograph of drawing 10 and drawing 13 by a prismatic form, cylindrical shape, the shape of a pyramid, conical shape, the shape of a reverse pyramid, or reversed conical shape. With the surface of a substrate, there are what is straight extended in rectangular directions or the inclined direction, a thing extended while it is curved or crooked, a thing which branched in the shape of a branch and has been extended, a thing of the shape of those complex, etc. As the whole shape, expression of the versatility of pillar-shaped \*\* assembled with the shape of ice needles, the shape of a nap-raising carpet, the shape of coral, the shape of a colonnade, and blocks can show. The thickness of those detailed pillars, height, the size of the root (bottom), etc. change with heating conditions etc.

[0057]

The member which the detailed pillar which stands close together on the narrow height which a large number which are the 2nd multifunctional material used by this invention, and which consist of titanium oxide or a titanium alloy oxide on a thin film followed, and this height has exposed, It can conclude that the narrow height which the large number followed is carrying out appearance of the outside of the husks of a walnut, and appearance of a pumice stone, and each continuous narrow height can be expected to crook the pattern of \*\*\*\*\* or the letter of shrinkage so that it may be judged from the microphotograph of drawing 12. Although the shape of the detailed pillar which stands close together on this height is the same as the shape of each detailed pillar of the layer which bristles with the detailed pillar on the above-mentioned base, Since it is cut by many by the joined part of a detailed pillar and a thin film, the density of the detailed pillar which stands close together on this height generally becomes small rather than the density of the detailed pillar of a layer in which the detailed pillar on the above-mentioned base stands close together.

[0058]

The 3rd multifunctional material used by this invention provides the multifunctional layer

containing the titanium oxide by which carbon was doped with techniques, such as coating, or the powder (henceforth carbon dope titanium oxide powder) of titanium alloy oxidation in a base surface. The multifunctional layer in this case is formed of the coating agent containing carbon dope titanium oxide and an inorganic system binder. here -- as an inorganic system binder -- the partial condensate of alkoxysilane, such as ethyl silicate, and alkoxysilane, and silica -- sol etc. can be mentioned.

[0059]

The carbon dope titanium oxide powder used for such 3rd multifunctional material can be formed like the manufacturing method of the 1st multifunctional material by heat-treatment using the burning flame etc. of the gas which uses hydrocarbon, especially acetylene as the main ingredients, using titanium powder as a base. In this case, when powdered particle diameter is small, it is possible to use the whole particle as carbon dope titanium oxide by the above heat-treatment, but for this use, only a surface layer should serve as carbon dope titanium oxide, therefore it is not restricted at all about powdered particle diameter. However, when the ease of heat-treatment and the ease of manufacture are taken into consideration, it is preferred that it is not less than 15 nm.

[0060]

Carbon dope titanium oxide powder can be obtained by grinding the thin film which has the 2nd detailed pillar or detailed pillar of multifunctional material.

[0061]

In any case, especially the thing by which carbon dope titanium oxide powder was doped in the state of Ti-C combination of carbon is preferred, and the effect is as having mentioned above.

[0062]

Below, the function of the multifunctional material used by this invention is explained still in detail based on an example and a comparative example.

[0063]

Examples 1-3 (1st multifunctional material)

Carbon formed the titanium plate which has the carbon dope titanium oxide layer doped in the state of Ti-C combination as a surface layer by heat-treating a 0.3-mm-thick titanium plate using the burning flame of acetylene, so that the skin temperature may be about 1100 \*\*. The titanium plate which has a carbon dope titanium oxide layer from which carbon doped quantity and carbon dope titanium oxide layer thickness differ was formed by adjusting the heat-treatment time in 1100 \*\* to 5 seconds (example 1), 3 seconds (example 2), and 1 second (example 3), respectively.

[0064]

The carbon content was calculated with an X-ray fluorescence device about the carbon dope titanium oxide layer doped in the state of Ti-C combination of the carbon formed in these Examples 1-3. If the molecular structure of  $\text{TiO}_2\text{-xCx}$  is assumed based on the carbon content,

About  $\text{TiO}_{1.90}\text{C}_{0.10}$  and Example 3, it was [ Example / 1 / Example / 2 /  $\text{TiO}_{1.76}\text{C}_{0.24}$  and ]

$\text{TiO}_{1.95}\text{C}_{0.05}$  carbon-content 1.7at% carbon-content about 3.3 at(s)% carbon-content 8at%.

The carbon dope titanium oxide layer doped in the state of Ti-C combination of the carbon formed in Examples 1-3 was super-hydrophilic nature whose angle of contact with waterdrop is about 2 degrees.

[0065]

Comparative example 1

After carrying out the spin coat of the titanium oxide sol (Ishihara Sangyo STS-01) marketed to a 0.3-mm-thick titanium plate, the titanium plate which has the titanium oxide coat which heated and improved adhesion was formed.

[0066]

Comparative example 2

Titanium oxide used the commercial item by which the spray coat is carried out as the base which has a titanium oxide coat of the comparative example 2 on the SUS board.

[0067]

The example 1 (Vickers hardness) of an examination

About the carbon dope titanium oxide layer and the titanium oxide coat of the comparative example 1 which were doped in the state of Ti-C combination of carbon of Example 1, with a nano hardness tester (NHT) (product made from CSM Instruments of Switzerland). Indenter: When coat hardness was measured under the conditions of a bell KOBITCHI type, test force:2mN, and load unloading speed:4 mN/min, the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon of Example 1 was a value with as high Vickers hardness as 1340. On the other hand, the Vickers hardness of the titanium oxide coat of the comparative example 1 was 160.

[0068]

These results are shown in drawing 1. The literature value (from Ohm-Sha (1971) to Tomono, a "practical use plating manual", Chapter 6, and quotation) of the Vickers hardness of a hard-chromium-plating layer and a nickel plating layer is collectively shown for reference. It is clearer than a nickel plating layer and a hard-chromium-plating layer that the carbon dope titanium oxide layer's doped in the state of Ti-C combination of carbon of Example 1 it is high hardness.

[0069]

The example 2 (scratch-proof nature) of an examination

About the carbon dope titanium oxide layer and the titanium oxide coat of the comparative example 1 which were doped in the state of Ti-C combination of carbon of Example 1, with a micro scratch tester (MST) (product made from CSM Instruments of Switzerland). Indenter: The scratch-proof sex test was carried out under the conditions of Rockwell (diamond), tip-radius [ of 200 micrometers ], and initial load:0N, breaking load:30N, load speed:50 N/min, scratch length:6mm, and stage speed:10.5 mm/min. The "complete exfoliation" load from which exfoliation of a film takes place to the "exfoliation start" load from which exfoliation of a small film arises into scratch marks, and the whole scratch marks was searched for. The result was as being shown in the 1st table.

[0070]

[Table 1]

第 1 表

	実施例 1	比較例 1
剥離開始荷重 (N)	1 8 . 7	3 . 7
全面剥離荷重 (N)	2 5 . 7	5 . 9

[0071]

The example 3 (abrasion resistance) of an examination

About the carbon dope titanium oxide layer and the titanium oxide coat of the comparative example 1 which were doped in the state of Ti-C combination of carbon of Example 1, in elevated-temperature TORAIBO meter (HT-TRM) (product made from CSM Instruments of Switzerland). Test temperature: The wear test was carried out under the conditions of turning-radius: 1mm and rotating-speed-for-test: 1000 rotation room temperature and 470 \*\*, SiC with a ball: diameter of 12.4 mm ball, and load: 1N and sliding speed: 20mm/sec.

[0072]

As a result, although exfoliation occurred [ coat / of the comparative example 1 / titanium oxide ] about a room temperature and 470 \*\* both, about the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon of Example 1, trace wear significant under a room temperature and both 470 \*\* conditions was not detected.

[0073]

The example 4 (chemical resistance) of an examination

After carbon of Example 1 immerses the titanium plate which has the carbon dope titanium oxide layer doped in the state of Ti-C combination for one week at a room temperature, respectively in 1M sulfuric acid solution and 1M sodium hydroxide solution, When the above-mentioned coat hardness, abrasion resistance, and the photoelectric current density that carries out a postscript were measured, the difference significant to a result was not accepted before and after immersion. That is, it was accepted that the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon of Example 1 has high chemical resistance.

[0074]

The example 5 (structure of the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon) of an examination

About the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon of Example 1, with X linear-light electronic-spectroscopic-analysis device (XPS), it was referred to as accelerating voltage: 10kV and target: aluminum, Ar ion sputtering during 2700 seconds was performed, and analysis was started. Depth will be set to about 173 nm if this sputtering rate

sets to s in 0.64A /of a  $\text{SiO}_2$  film. The result of the XPS analysis is shown in drawing 2. When binding energy is 284.6 eV, the highest peak appears. This is judged to be C-H (C) combination generally seen to Cls analysis. Next, when high peaks are 281.7 eV of binding energies, it sees. Since the binding energy of Ti-C combination is 281.6 eV, in the carbon dope titanium oxide layer of Example 1, it is judged that C is doped as Ti-C combination. As a result of conducting XPS analysis by 11 points of the position from which the depth direction of a carbon dope titanium oxide layer differs, the same peak as about 281.6 eV appeared at all the points.

[0075]

Ti-C combination was checked also on the boundary of a carbon dope titanium oxide layer and a base. Therefore, it is expected that hardness is high by Ti-C combination in a carbon dope titanium oxide layer, and coat peel strength is remarkably large by Ti-C combination on the boundary of a carbon dope titanium oxide layer and a base.

[0076]

The example 6 (wavelength response) of an examination

Carbon of Examples 1-3 measured the wavelength response of the carbon dope titanium oxide layer and the titanium oxide coat of the comparative examples 1 and 2 doped in the state of Ti-C combination using the monochromator of Oriel. To each layer and a coat, voltage was impressed 0.3V between counter electrodes in the 0.05M sodium sulfate aqueous solution, and, specifically, photoelectric current density was measured.

[0077]

The result is shown in drawing 3. The obtained photoelectric current density  $j_p$  is shown in drawing 3 to irradiation wave length. The wavelength absorption end of the carbon dope titanium oxide layer doped in the state of Ti-C combination of carbon of Examples 1-3 has amounted to 490 nm, and it was accepted that photoelectric current density increases with increase of carbon doped quantity. Although not shown here, when it became the tendency for current density to decrease when carbon doped quantity exceeded 10at%, and also 15at% was exceeded, it turned out that the tendency becomes remarkable. Therefore, it was accepted that an optimum value has carbon doped quantity in about 1-10at%. On the other hand, in the titanium oxide coat of the comparative examples 1 and 2, photoelectric current density was remarkably low, and it was admitted that the wavelength absorption end was also about 410 nm.

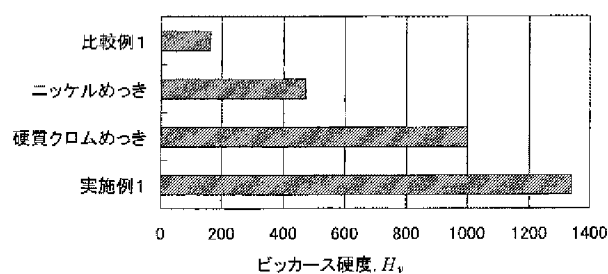
## \* NOTICES \*

JPO and INPIT are not responsible for any damages caused by the use of this translation.

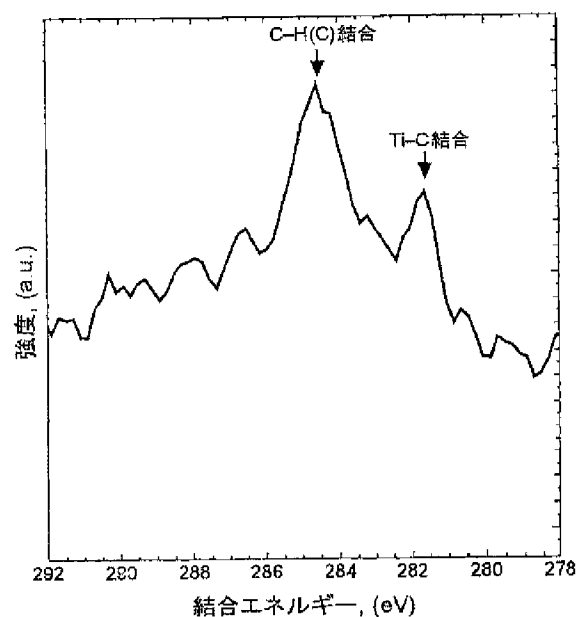
- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

## DRAWINGS

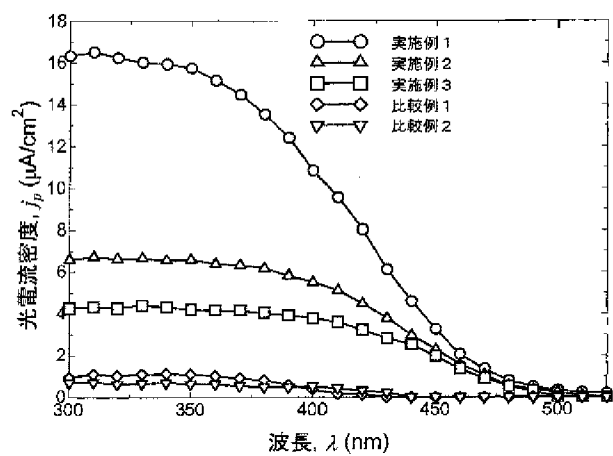
[Drawing 1]



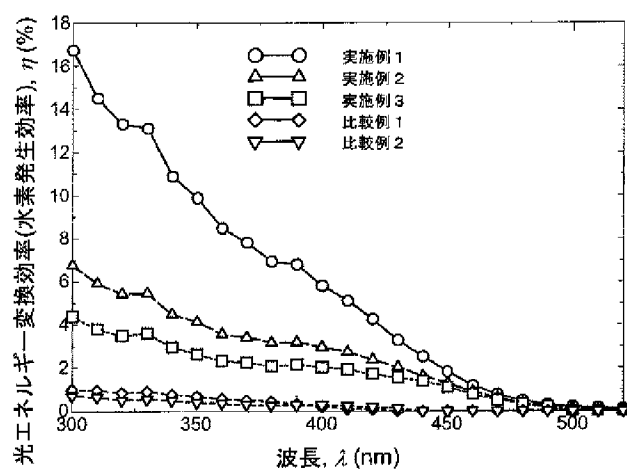
[Drawing 2]



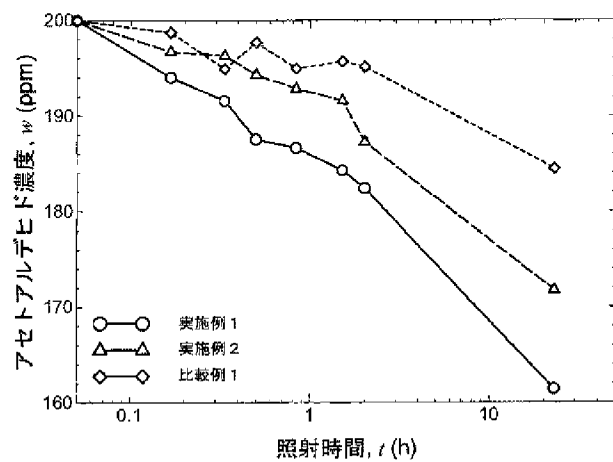
[Drawing 3]



[Drawing 4]

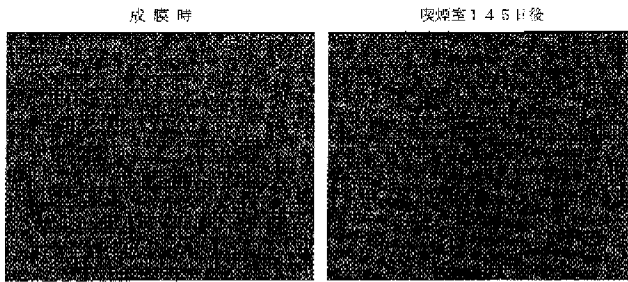


[Drawing 5]

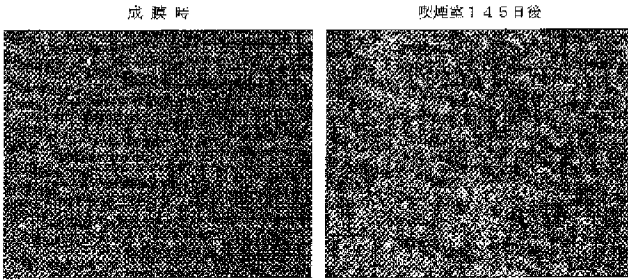


[Drawing 6]

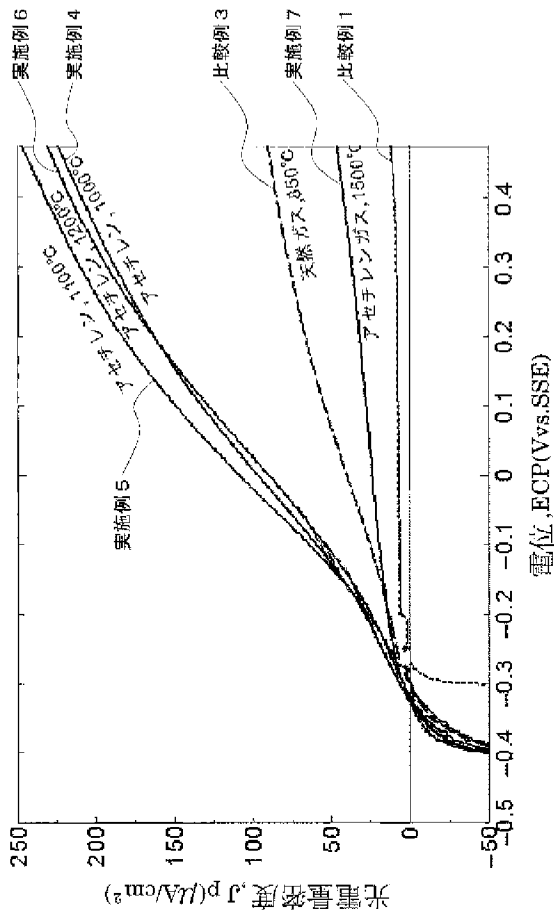
(a) 実施例1



(b) 比較例1



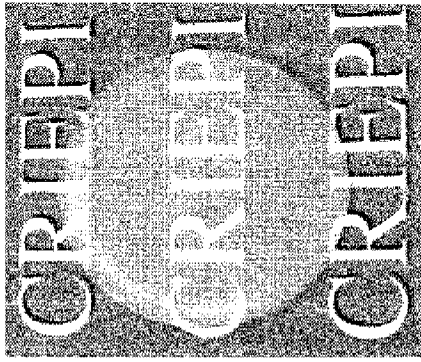
[Drawing 7]



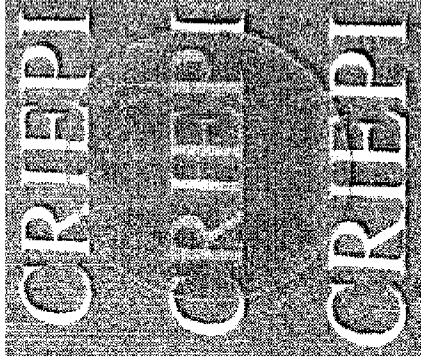
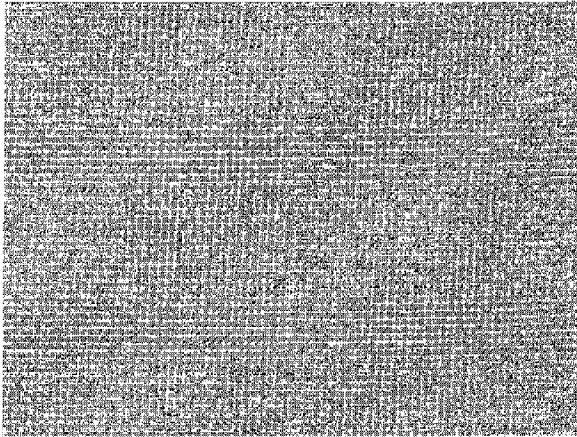
[Drawing 8]

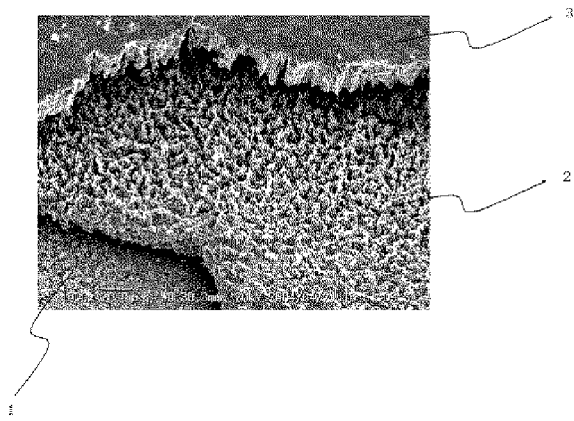


(b) 実施例 12

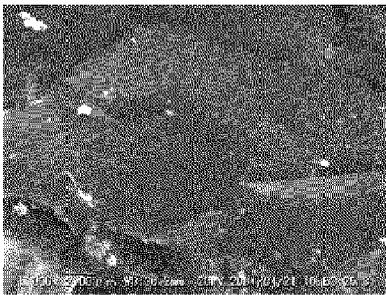


(a) 実施例 11

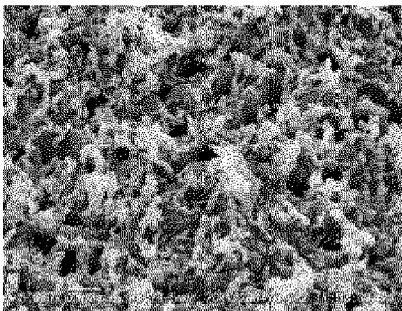
[Drawing 9][Drawing 10]



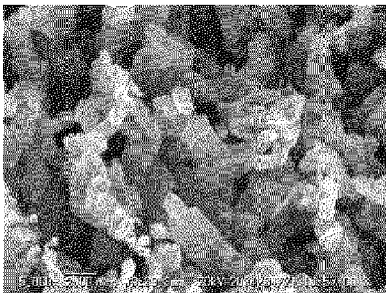
[Drawing 11]



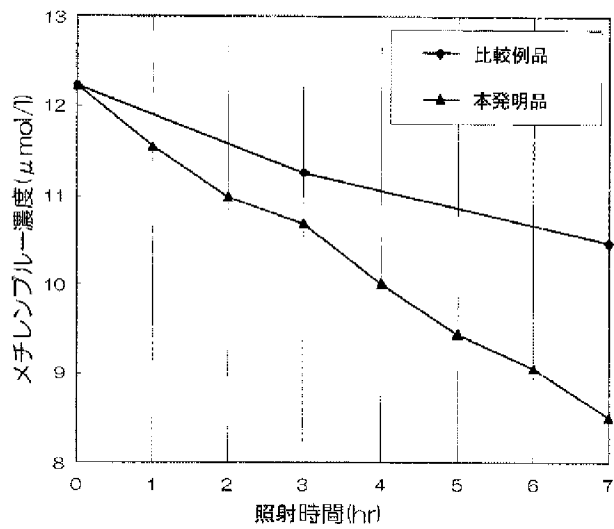
[Drawing 12]



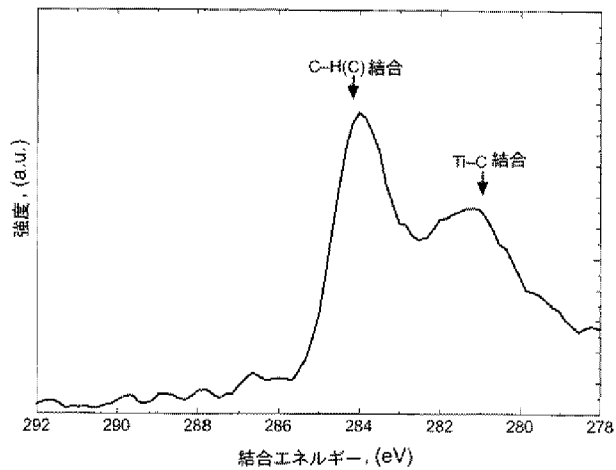
[Drawing 13]



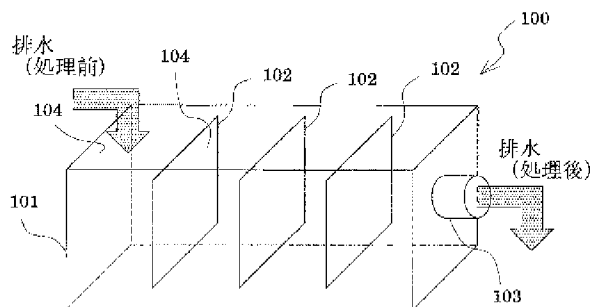
[Drawing 14]



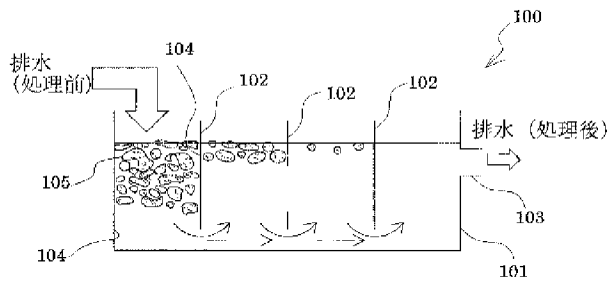
[Drawing 15]



[Drawing 16]



[Drawing 17]



---

[Translation done.]